Claims

1. A device for etching a substrate (10), a silicon body in particular, using an inductively coupled plasma (14), having an ICP source (13) for generating a radio-frequency electromagnetic alternating field and a reactor (15) for generating the inductively coupled plasma (14) from reactive particles by the action of the radio-frequency electromagnetic alternating field on a reactive gas,
characterized in that a first means is provided for generating plasma power pulses to be injected into the inductively coupled plasma (14) by the ICP source (13).

2. The device according to Claim 1,
characterized in that the first means is an ICP coil generator (17) which generates a variably adjustable, pulsed radio-frequency power with regard to the pulse to pause ratio of the plasma power pulses and/or the individual pulse power.

3. The device according to Claim 2,
characterized in that an impedance transformer (18) in the form of a matching network, in particular a balanced symmetrical matching network is provided for matching an initial impedance of the ICP coil generator (17) to a plasma impedance which is dependent on the individual pulse power of the plasma power pulses to be injected.

4. The device according to Claim 3,
characterized in that the impedance transformer (18) is preset in such a way that with a specified maximum individual pulse power of the plasma power pulses to be injected into the inductively coupled plasma (14) in the case of stationary power, an at least largely optimum impedance matching is ensured.

5. The device according to Claim 2, characterized in that components are integrated into the ICP coil generator (17) which, via a variation of the frequency of the generated electromagnetic alternating field, perform impedance matching as a function of the individual pulse power to be injected.

6. The device according to Claim 5, characterized in that the ICP coil generator (17) is provided with an automatically acting feedback circuit having a frequency-selective component (1), the feedback circuit having at least one controlled power amplifier, a frequency-selective band filter with a stationary frequency (1'') to be attained and a delay line (7) or a phase shifter.

7. The device according to at least one of the preceding claims, characterized in that a second means is provided which generates a static or time-variable, particularly pulsed magnetic field between the substrate (10) and the ICP source (13).

8. The device according to Claim 7, characterized in that the first means is a magnetic field coil (21) with an associated power supply unit (23) or a permanent magnet, the magnetic field generated by the magnetic field coil (21) via the power supply unit (23) being time-variable, capable of being pulsed in particular.

9. The device according to Claim 1, characterized in that a substrate voltage generator (12) is provided with which a continuous or time-variable radio-frequency power, a pulsed radio-frequency power in particular, can be applied to a substrate (10) arranged on a substrate electrode (11).

10. The device according to Claim 9,
characterized in that a first impedance transformer (12) is provided for impedance matching between the substrate voltage generator (12) and the substrate (10).

11. The device according to at least one of the preceding claims,
characterized in that the ICP coil generator (17) is connected to the substrate voltage generator (12) and/or the power supply unit (23).

12. A method for etching a substrate (10), a silicon body in particular, having a device according to at least one of the preceding claims,
characterized in that a pulsed radio-frequency power is injected into the inductively coupled plasma (14) as a pulsed plasma power, at least from time to time.

13. The method according to Claim 12,
characterized in that the pulsed plasma power is injected via an ICP source (13) to which a radio-frequency electromagnetic alternating field having a constant frequency or a frequency which varies within a frequency range is applied around a stationary frequency (1'').

14. The method according to Claim 12,
characterized in that the pulsed radio-frequency power is generated with an ICP coil generator (17) which is pulse-operated with a frequency of 10 Hz to 1 MHz and pulse to pause ratio of 1:1 to 1:100.

15. The method according to Claim 12,
characterized in that a plasma power of 300 watts to 5000 watts on the time average is injected into the inductively coupled plasma (14) and that the generated individual pulse powers of the radio-frequency power pulses are between 300 watts and 20 kilowatts, in

particular 2 kilowatts to 10 kilowatts.

16. The method according to Claim 12 or 13, characterized in that the pulsing of the injected radio-frequency power is accompanied by a change of the frequency of the injected radio-frequency power, the frequency change being controlled in such a way that the plasma power injected into the inductively coupled plasma (14) during the pulsing is maximized.

17. The method according to at least one of Claims 12 to 16, characterized in that during the etching, a static or time-variable, in particular periodically varying or pulsed magnetic field is generated, the direction of which is at least approximately or predominantly parallel to a direction defined by the connecting line of the substrate (10) and the inductively coupled plasma (14).

18. The method according to Claim 17, characterized in that the magnetic field is generated in such a way that it extends into the area of the substrate (10) and the inductively coupled plasma (14) and has a field strength amplitude between 10 MTesla and 100 mTesla in the interior of the reactor (15).

19. The method according to Claim 17 or 18, characterized in that a magnetic field pulsed at a frequency of 10 Hz to 20 kHz is generated via the power supply unit (23), the pulse to pause ratio when the magnetic field is pulsed being between 1:1 and 1:100.

20. The method according to at least one of the preceding claims, characterized in that a constant or time-variable, in particular pulsed, radio-frequency power is applied to the substrate (10) via a substrate voltage generator (12).

21. The method according to Claim 20, characterized in that the pulse duration of the radio-frequency power injected into the substrate is between one to one hundred times, one to ten times in particular, the period of oscillation of the high-frequency fundamental component of the radio-frequency power.

22. The method according to Claim 20 or 21, characterized in that the radio-frequency power applies a time-average power of 5 watts to 100 watts to the substrate (10), the maximum power of an individual radio-frequency power pulse being one to 20 times, in particular twice to 10 times, the time average power.

23. The method according to Claim 21, characterized in that the frequency of the injected radio-frequency power is between 100 kHz to 100 MHz, 13.56 MHz in particular, and that the pulse to pause ratio of the injected radio-frequency pulses is between 1:1 and 1:100, 1:1 and 1:10 in particular.

24. The method according to at least one of the preceding claims, characterized in that the pulsing of the injected plasma power and the pulsing of the radio-frequency power injected into the substrate (10) via the substrate voltage generator (12) or the pulsing of the magnetic field, the pulsing of the injected plasma power and the pulsing of the radio-frequency power injected into the substrate (10) via the substrate voltage generator (12) are time-correlated or synchronized with each other.

25. The method according to Claim 24, characterized in that the correlation takes place in such a way that the magnetic field is first applied, before a radio-frequency power pulse of the ICP coil generator (17), and the magnetic field is switched off again after

the decay of this radio-frequency power pulse.

26. The method according to Claim 24 or 25, characterized in that the correlation takes place in such a way that during a radio-frequency power pulse of the ICP coil generator (17), the radio-frequency power injected into the substrate (10) via the substrate voltage generator (12) is switched off and/or that during a radio-frequency power pulse injected into the substrate (10) via the substrate voltage generator (12), the radio-frequency power injected via the ICP coil generator (17) is switched off.

27. The method according to Claim 24 or 25, characterized in that the synchronization takes place in such a way that during each time of a plasma power pulse injected into the plasma (14) via the ICP coil generator (17), radio-frequency pulses injected into the substrate (10) via the substrate voltage generator (12) are also applied to the substrate (10).

Add A7

28. The method according to Claim 24 or 25, characterized in that the correlation takes place in such a way that the radio-frequency power injected into the substrate (10) via the substrate voltage generator (12) is generated in each case during a power rise and/or a power drop of a radio-frequency power pulse injected into the plasma (14) via the ICP coil generator (17).

29. The method according to Claim 24 or 25, characterized in that the correlation takes place in such a way that during the time of the plasma power pulses injected into the plasma (14) via the ICP coil generator (17) and during the time of the pulse pauses between the individual plasma power pulses injected into the plasma (14) via the ICP coil generator (17), at least one radio-frequency power pulse injected into the substrate (10) via the substrate voltage generator (12) is applied to the substrate (10) in each case.

30. The method according to one of the preceding claims, characterized in that the etching takes place in alternating etching and passivation steps at a process pressure of 5 μbar to 100 μbar.

add A7

add B5